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and Interface
for Haystack 490 Computer**J. E. Gillis
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GENERAL-PURPOSE I/O CHANNEL AND INTERFACE
FOR HAYSTACK 490 COMPUTER

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ABSTRACT

A general-purpose interface has been constructed for Channel 5 of the Haystack Univac 490 digital computer. Data inputs are from the radiometer and a general-purpose A/D converter while outputs are a display of right ascension, declination, and hour angle, a CRT display and strip chart recorder, and control of the radiometer and other general-purpose functions.

Accepted for the Air Force
Franklin C. Hudson
Chief, Lincoln Laboratory Office

GENERAL-PURPOSE I/O CHANNEL AND INTERFACE FOR HAYSTACK 490 COMPUTER

I. GENERAL

Group 62 has constructed a general-purpose interface for channel 5 on the Univac 490. The inputs to the interface are:

- (a) Radiometry Data
- (b) General-Purpose A/D Converter

These inputs are selected by manual connection of the correct cable. (If desirable at some later date, this selection can be mechanized and/or other inputs can be added.) Communication with the 490 is via the standard REQUEST/ACKNOWLEDGE signals, and buffered input block transfers are thus permitted; all 30 data bits are used.

The output portion of the channel is demultiplexed to permit 6 (expandable to 16) functions:

- (a) General-Purpose Control
- (b) Right Ascension (for display)
- (c) Declination (for display)
- (d) Radiometry Control
- (e) Interim CRT Display/Strip Chart Recorder
- (f) Hour Angle (for display)

Communication from the 490 is via the EXTERNAL FUNCTION command, and output is therefore limited to single-word transfers. The output word contains 26 data bits and 4 function selection bits.

II. INPUT

A. Radiometry Data

Radiometry data is sent from the radiometry equipment (DIGITAL DATA COUPLER)* to the general-purpose interface and then to the 490. The

*S. Weinreb, "Digital Data Handling System for Haystack Radiometers," M. I. T. Lincoln Laboratory Memorandum (27 May 1963). (Not generally available.)

cable connector at the interface is a Winchester 104-pin connector; pin assignments are shown in Fig. 1. Logic levels on the cable between the radiometry equipment and the interface for both data and control signals are:

0 volts = logical '1'
-6 volts = logical '0'

Logic levels on the cable between the interface and the 490 for both data and control signals are:

0 volts = logical '1'
-3 volts = logical '0'

Timing is shown in Fig. 2. When the radiometry equipment has data ready for transmission to the 490, it first sets the data lines and then sets the INPUT DATA REQUEST line. Some time later (possibly as soon as 8 μ s later, but can be much longer, depending on the I/O machinations), the 490 sets the INPUT ACKNOWLEDGE line indicating that the data has been accepted. At this time, the radiometry equipment must reset the INPUT DATA REQUEST line.

The 490 will eventually reset the ACKNOWLEDGE line, but the radiometry equipment may legally generate another REQUEST before this occurs. The only requirement is that the equipment must wait at least 5 μ s after the end (reset) of the previous REQUEST before generating a new one.

B. General-Purpose A/D Converter

An Adage V9AB Voldicon A/D Converter is included as a part of the general-purpose interface. Figure 3 shows the converter and its associated logic. A list of the more important specifications on this machine is shown in Table I. (Refer to Adage Instruction Manual for more complete information.)

The converter quantizes analog inputs (on any of 20 addressable input channels) to a 9-bit number plus sign and also outputs a 5-bit word to identify the input analog channel.

Selection of the analog input can be controlled manually (locally) or automatically by remote equipment. It is also possible to arrange for

TABLE I

ADAGE VOLIDCON V9AB

Partial Specifications

I. INPUT

A. 20 Analog Channels Addressable Manually or Automatically,
4 channels with sample and hold.

B. Signal - ± 10 Volts or ± 0.1 ma

C. Trigger Mode - External, Internal or Line (Internal $\cong 500$ cps).

II. CONVERSION RATE

2500 Conversions/Second Maximum

III. OUTPUT

9 Bits Plus Sign, Also

5-Bit Channel Address

490 control of this selection by a cable connection. In this case, the program outputs selection commands on subchannel 4 with the format shown in Fig. 11.

In normal operation, the converter is triggered by an external trigger. When this occurs, the converter quantizes the input it is monitoring, and at the end of the conversion an INPUT DATA REQUEST is generated. When the 490 accepts the input, it generates an ACKNOWLEDGE signal which clears the REQUEST flip-flop. The external trigger must be inhibited until this flip-flop is cleared.

Timing of the external trigger with respect to channel selection signals must be controlled by external equipment to guarantee that channel selection is completed before the trigger occurs.

As indicated by the dotted lines in Fig. 3, modifications/additions can be made to include digital bookkeeping data inputs and bookkeeping logic in the system if an application requires it.

Analog inputs go to a cable connector on the converter itself; pin assignments are shown in Fig. 4. Channel selection, trigger, and any bookkeeping inputs go to a 104-pin Winchester plug; pin assignments are shown in Fig. 4.

The computer word format is shown in Fig. 5.

III. OUTPUT

Figures 6 and 7 show block diagrams of the output subchannels. Twenty-six data lines from the 490 go to a set of input amplifiers. The amplifier outputs then go to 6 sets of data gates. The remaining 4 data lines and the external function line go to other input amplifiers, the outputs of which go to the subchannel selection logic.

When an external function occurs on channel 5, this logic decodes the 4 selection bits and generates a gate which permits the 26 data lines to be gated to one set of data gates.

Subchannel 1

This is a general-purpose subchannel which is intended to be used to permit the program to exercise some control over the outside world. No

definite use has been established as yet, but it is probable that this subchannel will control several indicators and/or relays on the console.

This subchannel has internal storage, and the subchannel selection pulse triggers a set of one-shots which clears the storage and then gates data through the data gates into storage. The timing is shown in Fig. 8. Logic levels appearing on the 104-pin output connector are:

0 volts = logical '1'
-6 volts = logical '0'

Word format is shown in Fig. 9, and connector pin assignments are shown in Fig. 12.

Subchannels 2 and 3

These subchannels are used to provide displays of Right Ascension and Declination. Both channels have storage which is cleared and set in the same manner as subchannel 1.

The 490 supplies these functions in BCD. The storage consists of 6 BCD digits for RIGHT ASCENSION (hours, hours, minutes, minutes, seconds, seconds) and 6 BCD digits plus sign for DECLINATION (\pm degrees, degrees, minutes, minutes, seconds, seconds). The output of the storage goes to BCD/DECIMAL converters and light drivers. The light driver outputs appear on the output cable connector; pin assignments are shown in Fig. 13, and word format is shown in Fig. 10.

Subchannel 4

This subchannel is to be used to control the radiometry equipment and has no internal storage. Data is presented only during the time that the external function command exists which can be as short as 7.4 μ s (Fig. 8). Simultaneously with the data, a control signal is presented which is to be used to load the data into remote storage. Logic levels for both data and control are:

0 volts = logical '1'
-6 volts = logical '0'

Word format is shown in Fig. 11, and output connector pin assignments are shown in Fig. 12.

Subchannel 5

This subchannel is used to control a Sanborn Model 356-5460N strip chart recorder or two paralleled CRT displays (one Tektronix Type 555 and one Type 503). One display is rack mounted near the strip chart recorder, the other will be part of the console. The cables to both scopes and to the recorder are wired in parallel so that selection of the desired output is made by the program. (It is not desirable to interlace operation of these devices.)

This subchannel has storage which is cleared and set in the same manner as subchannel 1.

Four 6-bit D/A converters provide signals for 4 channels on the strip chart recorder so that it is possible to make an analog record of 4 simultaneous functions. One bit in the computer word is reserved to control the paper drive motor on the recorder.

Two 8-bit D/A converters provide x and y deflection signals for the CRT displays, and one bit in the computer word is reserved to control intensity.

Pin assignments for the output connector are shown in Fig. 14, and the word format is shown in Fig. 9.

Subchannel 6

This subchannel is used to provide an Hour Angle display; the subchannel storage is cleared and set in the same manner as subchannel 1.

The 490 supplies this data as 6 BCD digits (hours, hours, minutes, minutes, seconds, seconds).

The storage output goes to BCD/decimal converters and light drivers. The light driver outputs appear on the output cable connector; pin assignments are shown in Fig. 13, and word format is shown in Fig. 10.

Detailed Diagrams

A list of the detailed logic and circuit diagrams is shown in Table II. Figures 15, 16 and 17 are diagrams of the Univac amplifier cards used in the General Purpose I/O.

TABLE II
DRAWING LIST

| | | Lincoln Laboratory |
|----|---------------------------------|-----------------------|
| | | <u>DRAWING NUMBER</u> |
| 1. | Control Section | 23455 |
| 2. | Subchannel 1 | 23456 |
| 3. | Subchannel 2 | 23457 |
| 4. | Subchannel 3 | 23458 |
| 5. | Subchannel 4 | 23459 |
| 6. | Subchannel 5 | 23460 |
| 7. | Subchannel 6 | 23461 |
| 8. | Recorder and CRT Drive Circuits | 23462 |

| Bit No. | Pin No.* | Bit No. | Pin No. | Bit No. | Pin No. |
|--|----------|---------|---------|-----------------------|----------|
| 0 | A E | 12 | c h | 24 | AD AJ |
| 1 | B F | 13 | d i | 25 | AE AK |
| 2 | C H | 14 | f j | 26 | AF AL |
| 3 | D J | 15 | g k | 27 | AH AM |
| 4 | K P | 16 | m r | 28 | AN AT |
| 5 | L R | 17 | n s | 29 | AP AU |
| 6 | M S | 18 | p t | Control Signals | BU BY |
| 7 | N T | 19 | q u | | |
| 8 | U Y | 20 | v z | | |
| 9 | V Z | 21 | w AA | Input Data Request | BT BX |
| 10 | W a | 22 | x AB | Input Acknowledge | CJ CN |
| 11 | X b | 23 | y AC | External Interrupt | |
| * First pin of each pair is for signal, second pin may be used for ground. | | | | | |

Fig. 1. Pin assignments for general purpose interface input connector.

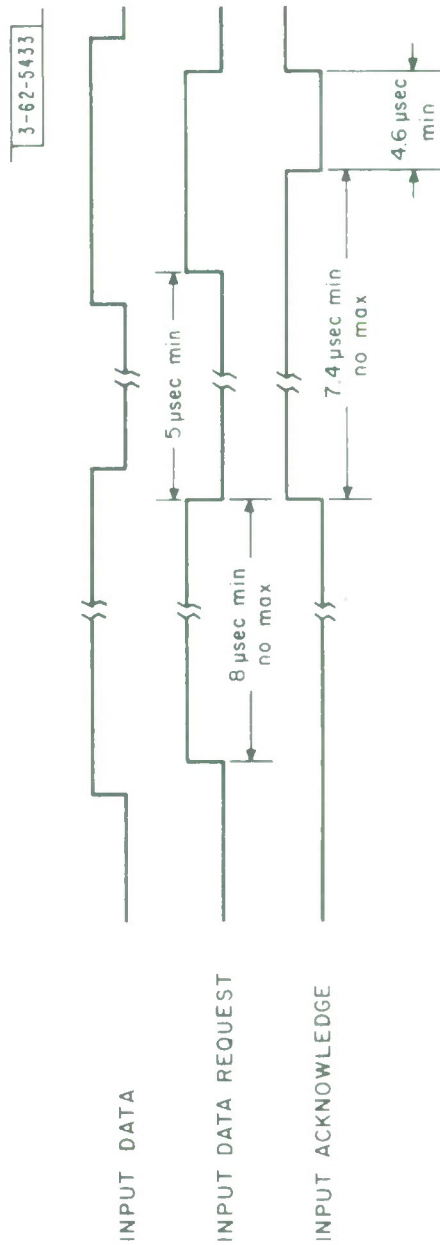


Fig. 2. Input timing.

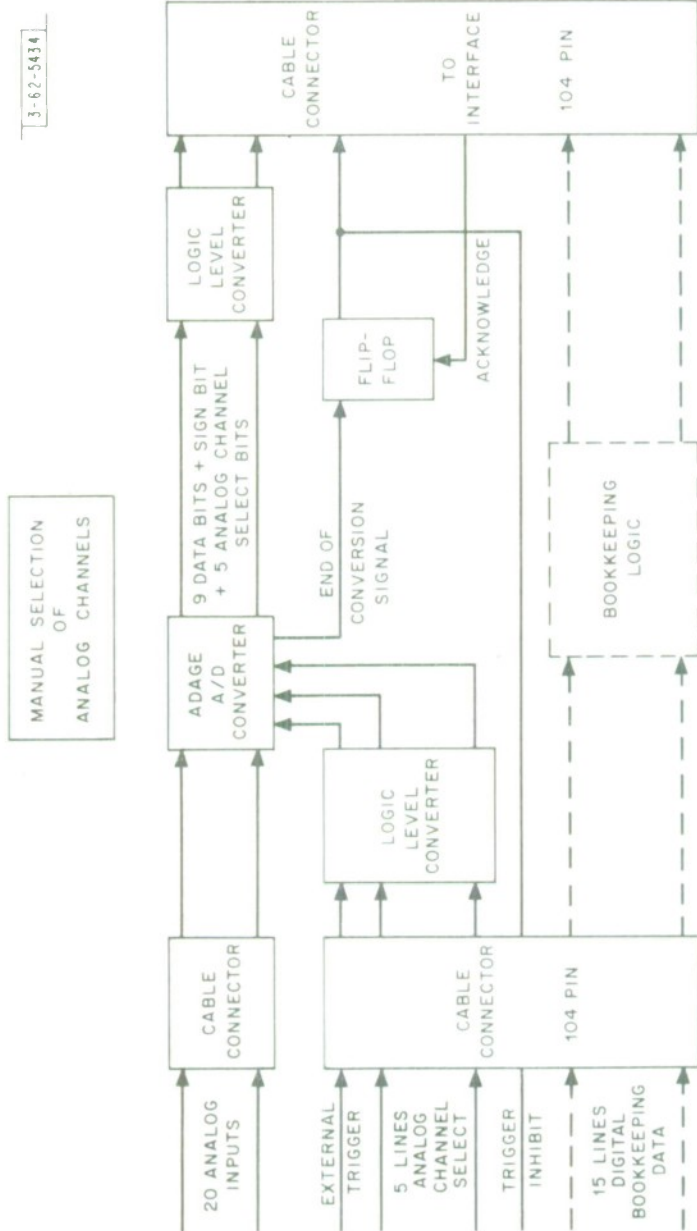


Fig. 3. General purpose A/D converter.

| Analog Input Connector | | Winchester Connector | | |
|------------------------|---------|----------------------|------------------------|------------------------|
| Channel No. | Pin No. | Function | Pin No. ⁽¹⁾ | |
| 0 | C | Ext. Trig. Inhibit | CL CR | |
| 1 | H | Ext. Trig. | CC CH | Channel Selection Bits |
| 2 | M | 10 ⁽²⁾ | BF BL | |
| 3 | s | 2* | BH BM | |
| 4 | w | 4 | BJ BN | |
| 5 | a | 2 | BK BP | |
| 6 | e | 1 | BR BV | |
| 7 | k | 15 ⁽³⁾ | g k | Bookkeeping Bits |
| 8 | r | 16 | m r | |
| 9 | v | 17 | n s | |
| 10 | D | 18 | p t | |
| 11 | J | 19 | q u | |
| 12 | N | 20 | v z | |
| 13 | T | 21 | w AA | |
| 14 | X | 22 | x AB | |
| 15 | b | 23 | y AC | |
| 16 | f | 24 | AD AJ | |
| 17 | m | 25 | AE AK | |
| 18 | S | 26 | AF AL | |
| 19 | W | 27 | AH AM | |
| Signal Return | AA | 28 | AN AT | |
| Shield | EE | 29 | AP AU | |

(1) First pin of each pair is signal, second pin may be used for ground.

(2) Numbers 10, 2*, 4, 2, 1 form a BCD code for channel selection.

(3) Numbers 15-29 refer to 490 word bit numbers.

Fig. 4. Input connectors for A/D converter.

Fig. 5. Input word formats.

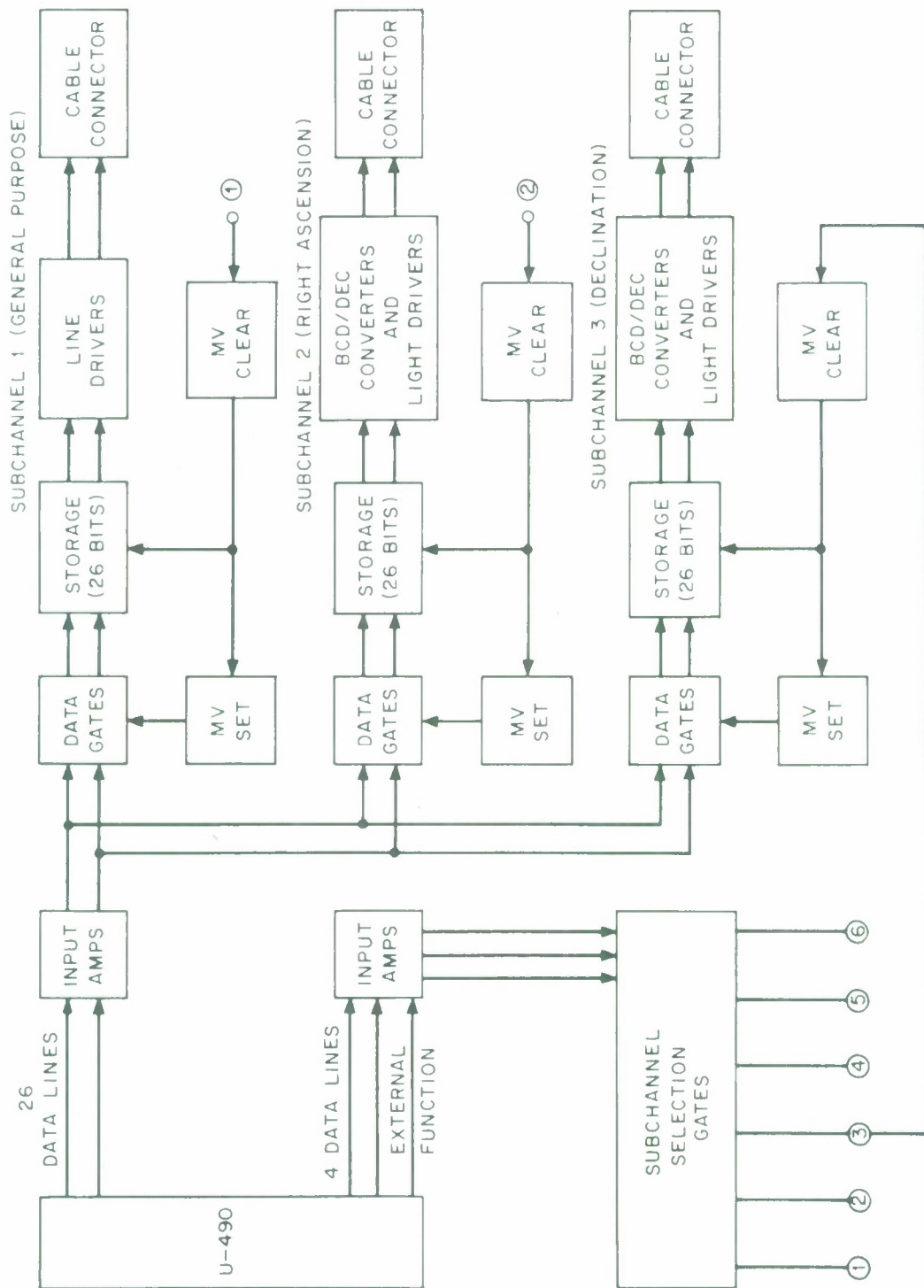


Fig. 6. Selection gates and subchannels 1-3.

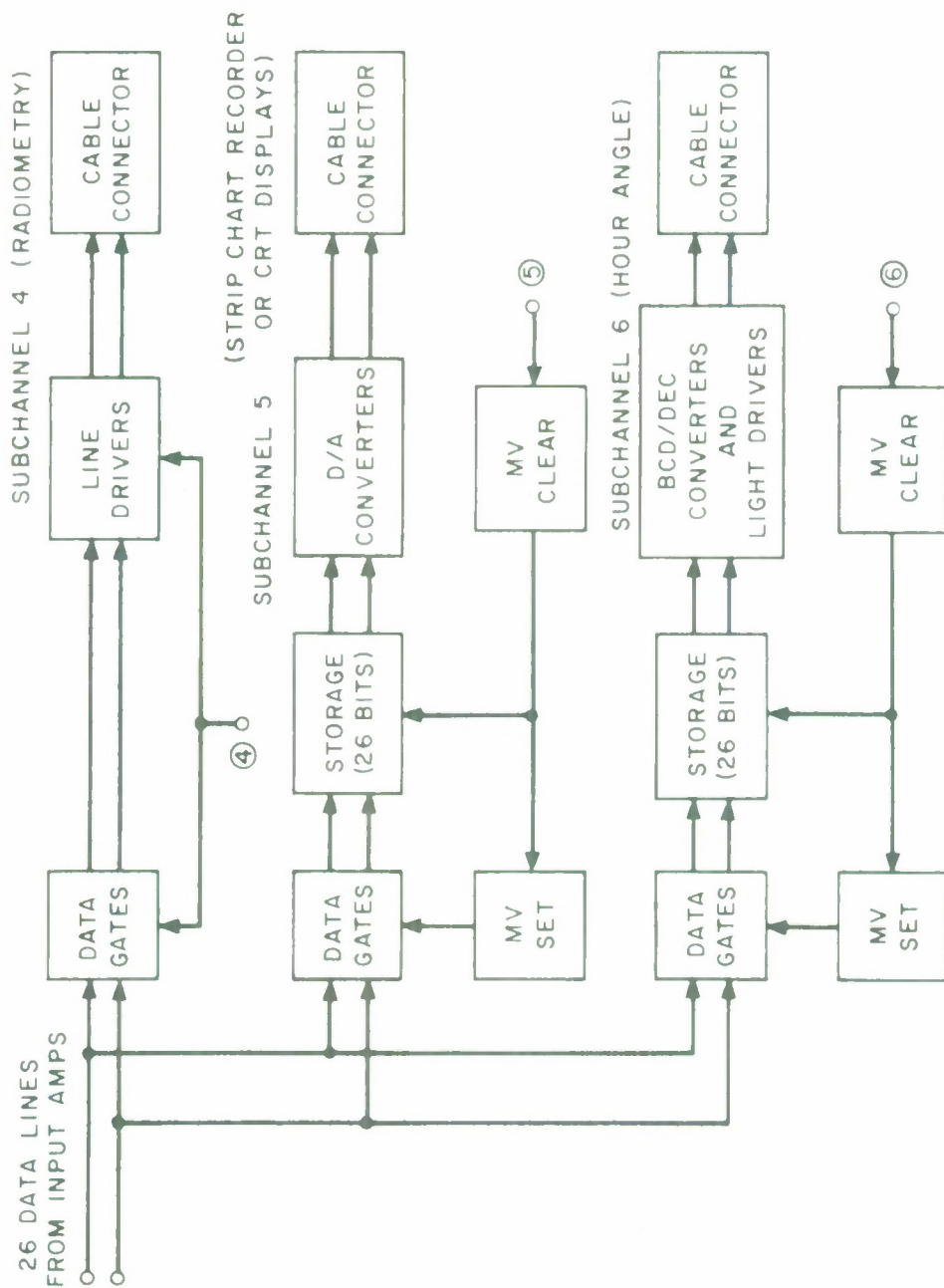


Fig. 7. Subchannels 4-6.

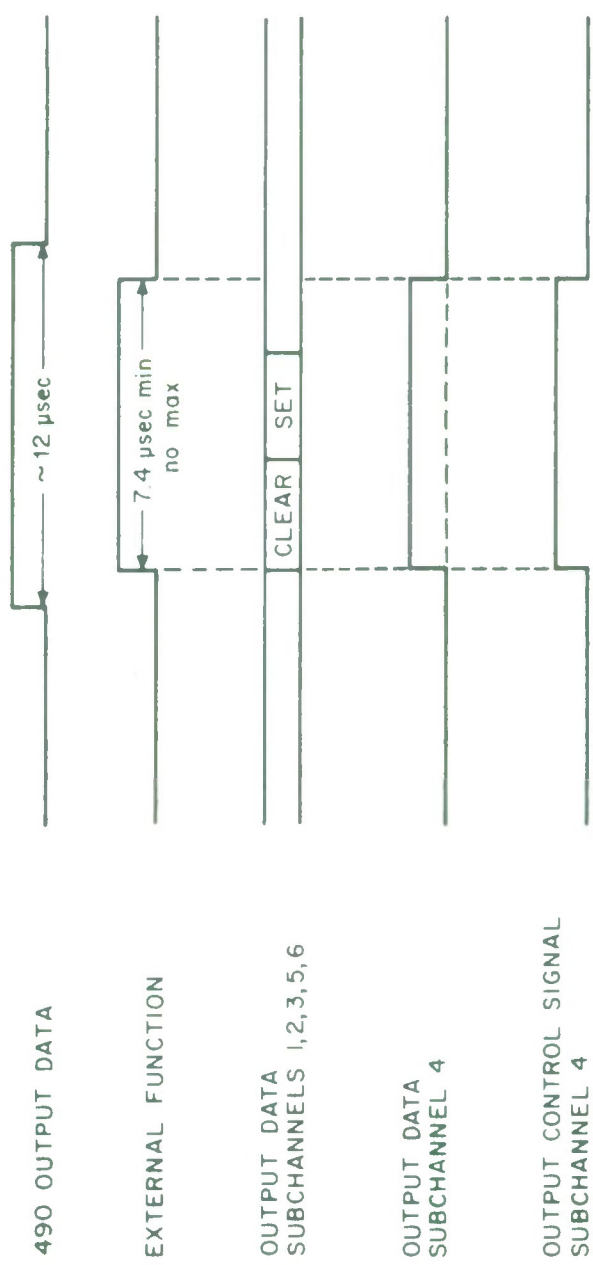


Fig. 8. Output timing.

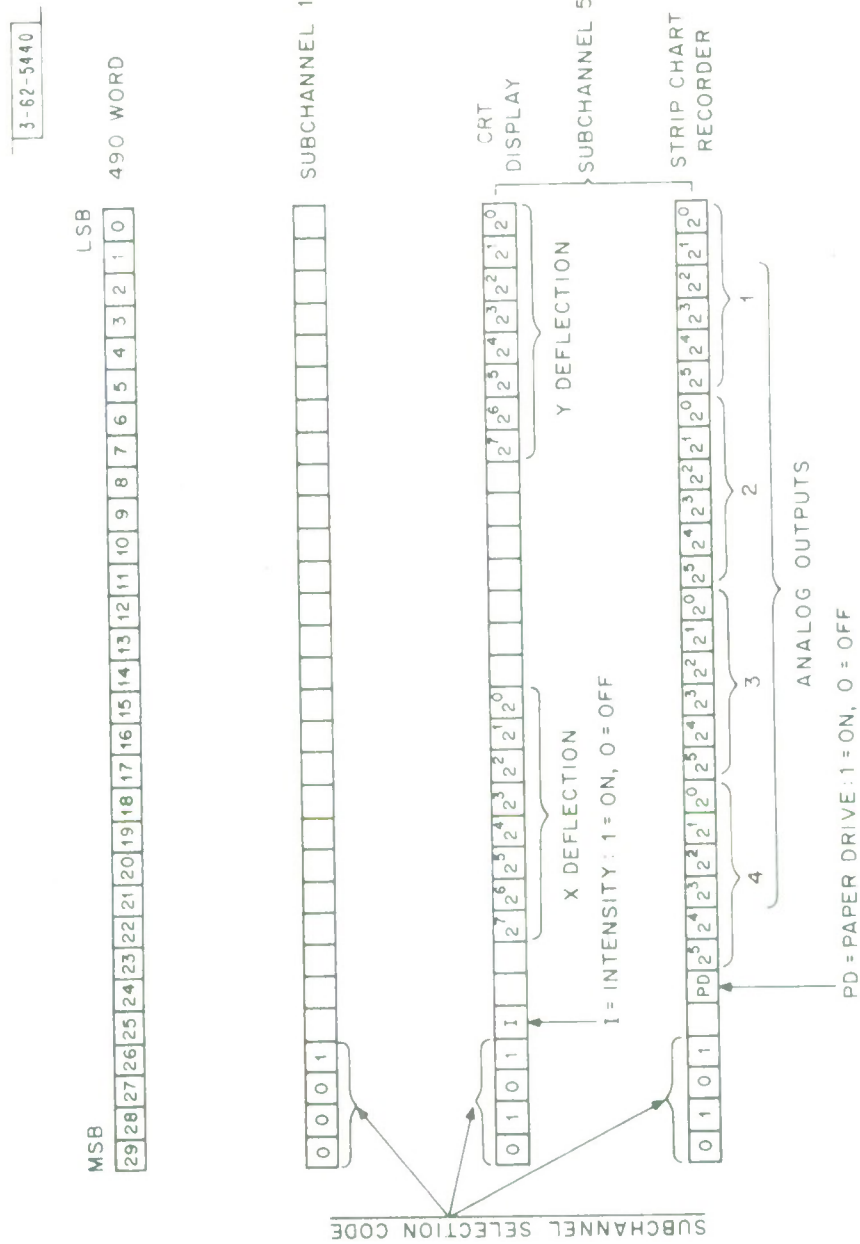


Fig. 9. Subchannels 1 and 5 word formats.

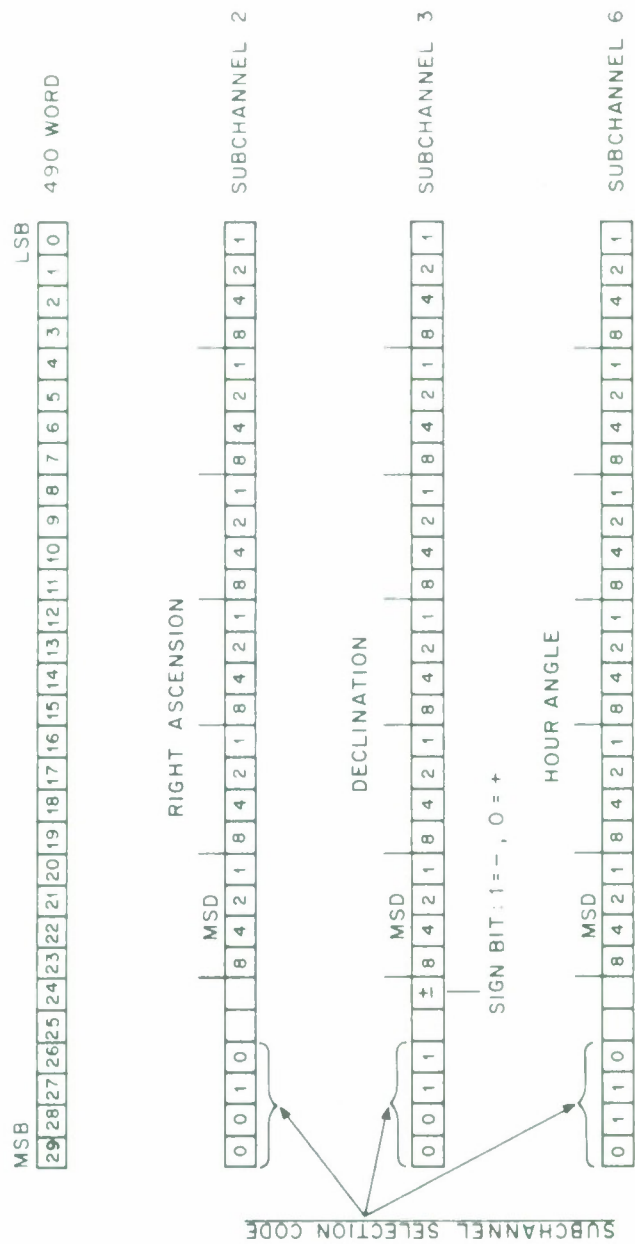


Fig. 10. Subchannels 2, 3, and 6 word formats.

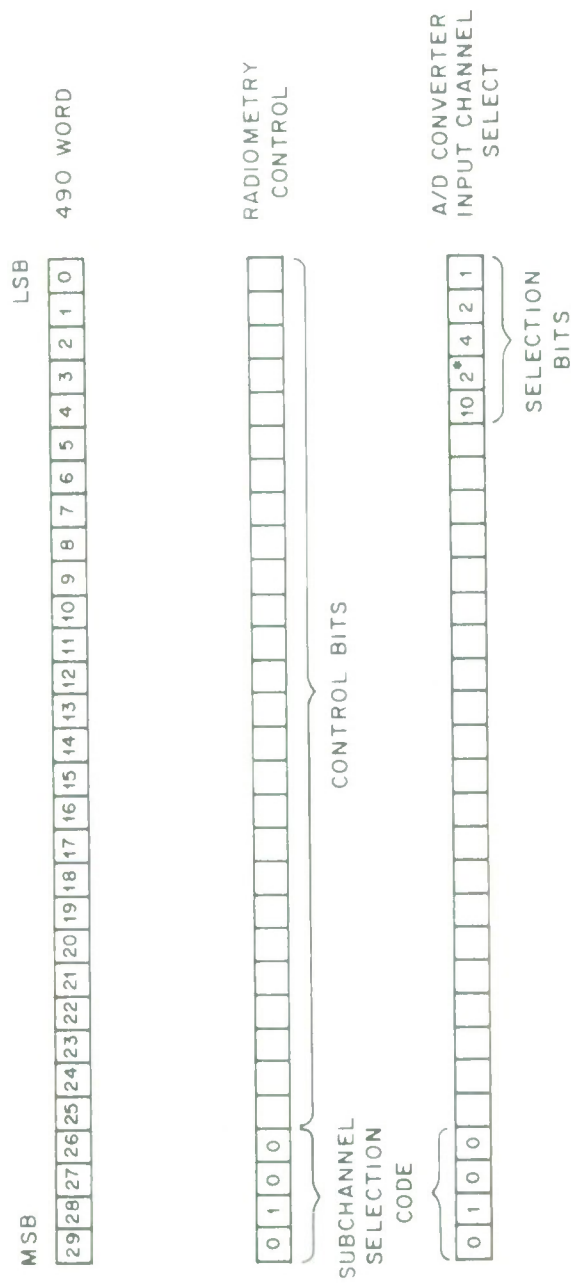


Fig. 11. Subchannel 4 word formats.

| Bit No. | Pin No.* | Bit No. | Pin No. |
|---|----------|----------|----------|
| 0 | A E | 15 | g k |
| 1 | B F | 16 | m r |
| 2 | C H | 17 | n s |
| 3 | D J | 18 | p t |
| 4 | K P | 19 | q u |
| 5 | L R | 20 | v z |
| 6 | M S | 21 | w AA |
| 7 | N T | 22 | x AB |
| 8 | U Y | 23 | y AC |
| 9 | V Z | 24 | AD AJ |
| 10 | W a | 25 | AE AK |
| 11 | X b | 26 | AF AL |
| 12 | c h | 27 | AH AM |
| 13 | d i | 28 | AN AT |
| 14 | f j | 29 | AP AU |
| External Function (subchannel 4 only) | | CJ CN | |
| * First pin of each pair is for signal; second pin may be used for ground. | | | |

Fig. 12. Pin assignments for subchannels 1 and 4 output connectors.

| Function | Pin No. | Function | Pin No. | Function | Pin No. |
|--------------------------------|---------|--------------|---------|-----------------------|---------|
| First (Most Significant) Digit | | Fourth Digit | | Sign | |
| 9 | AS | 9 | k | + | AX |
| 8 | AR | 8 | j | - | AY |
| 7 | AP | 7 | i | Nixie Driver Voltages | |
| 6 | AN | 6 | h | | |
| 5 | AM | 5 | g | | |
| 4 | AL | 4 | f | Strobe | BB |
| 3 | AK | 3 | d | CLR | BC |
| 2 | AJ | 2 | c | +80 volts | BD |
| 1 | B | 1 | b | D1 + 175 volts | BE |
| 0 | A | 0 | a | D2 + 175 volts | BF |
| Second Digit | | Fifth Digit | | D3 + 175 volts | BH |
| | | | | D4 + 175 volts | BJ |
| 9 | N | 9 | w | D5 + 175 volts | BK |
| 8 | M | 8 | v | D6 + 175 volts | BL |
| 7 | L | 7 | u | GND | BU |
| 6 | K | 6 | t | | |
| 5 | J | 5 | s | | |
| 4 | H | 4 | r | | |
| 3 | F | 3 | q | | |
| 2 | E | 2 | p | | |
| 1 | D | 1 | n | | |
| 0 | C | 0 | m | | |
| Third Digit | | Sixth Digit | | | |
| | | | | | |
| 9 | Z | 9 | AH | | |
| 8 | Y | 8 | AF | | |
| 7 | X | 7 | AE | | |
| 6 | W | 6 | AD | | |
| 5 | V | 5 | AC | | |
| 4 | U | 4 | AB | | |
| 3 | T | 3 | AA | | |
| 2 | S | 2 | z | | |
| 1 | R | 1 | y | | |
| 0 | P | 0 | x | | |

Fig. 13. Pin assignments for subchannels 2, 3, and 6 output connectors.

| Function | Pin No. |
|------------------------------|----------|
| Strip Chart Recorder Signals | |
| Channel 1 | BF BL |
| Channel 2 | BH BM |
| Channel 3 | BJ BN |
| Channel 4 | BK BP |
| Paper Drive | BR BV |
| Rack-Mounted CRT | |
| Horizontal | BY |
| Vertical | BS |
| Intensity | BU |
| Ground | BT |
| Console CRT | |
| Horizontal | CA |
| Vertical | CB |
| Intensity | CC |
| Ground | CH |

Fig. 14. Pin assignments for subchannel 5 output connector.

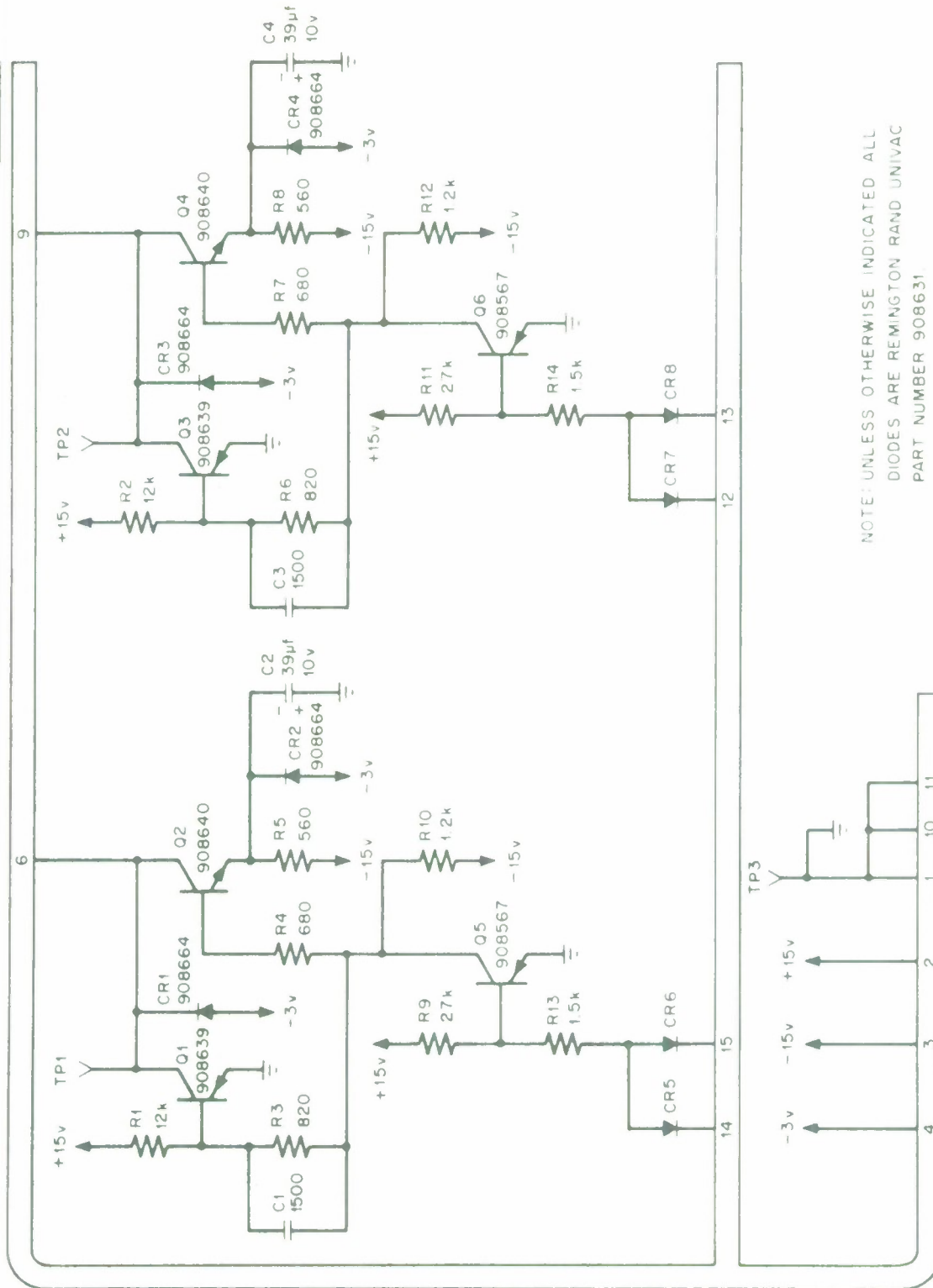


Fig. 15. Univac data line driver.

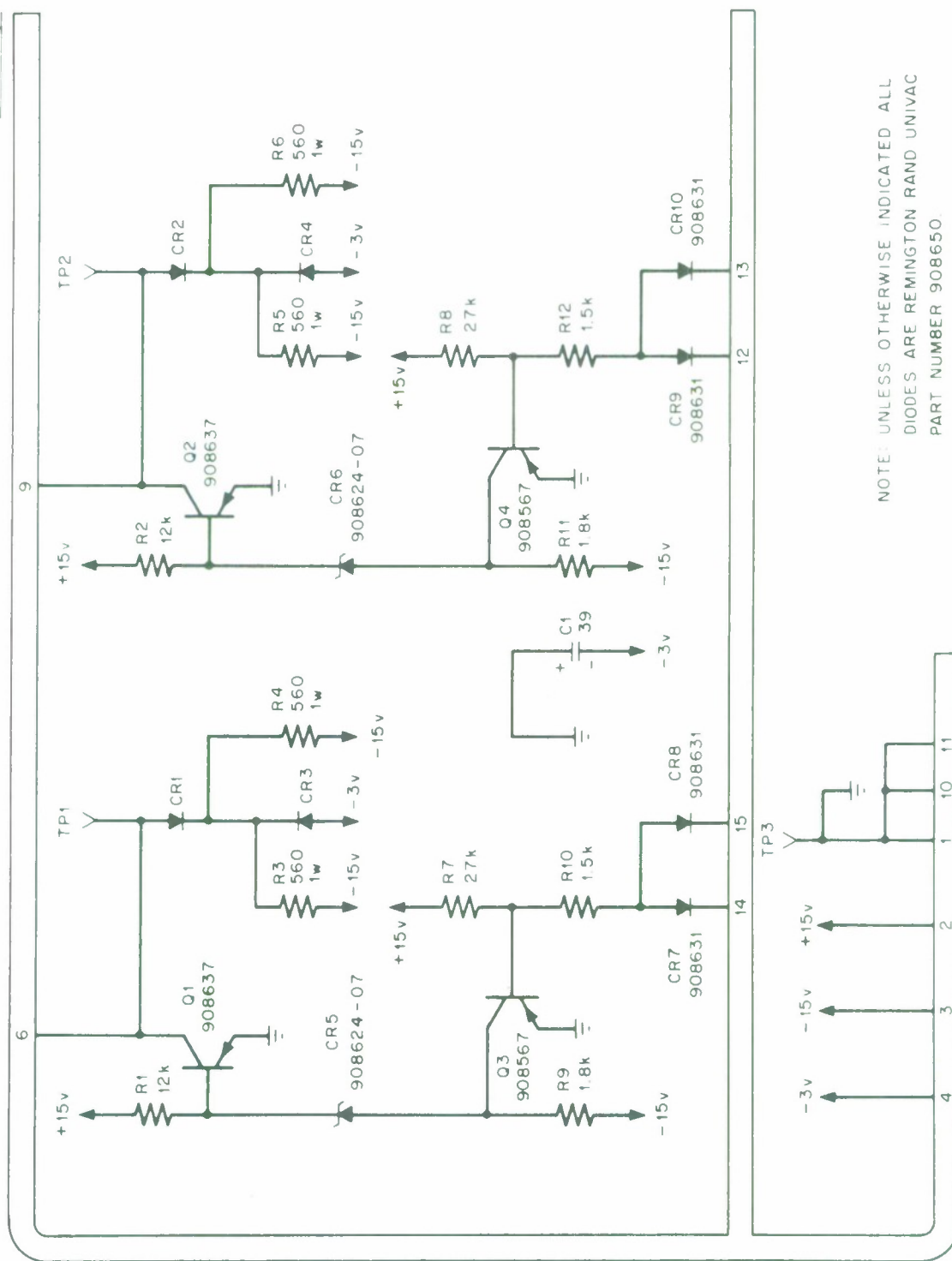


Fig. 16. Univac control line driver.

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